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EP 0482799 A1 **US 4933149 A**

(58) Field of Search
UK CL (Edition M) **B1F**
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ONLINE DATABASES: WPI AND CLAIMS

(54) Gas distributor plate for fluidized bed reactors

(57) A gas distributor plate for use in a fluidized bed reactor has holes arranged respectively at the vertices of a multiplicity of phantom squares adjoining to one another on the distributor plate, and also at positions close to a side wall of the reactor. Each of the holes being covered with a cap 2 having one outlet for directing the gas, so that polymer particles are prevented from adhering to the plate or agglomerating to ensure a stabilized operation for a long time.

As shown in Fig 6, all nozzles but the peripheral ones are aligned parallel to a tangent to the edge of the plate. The peripheral ones are directed more towards the circumference to clear particles from the reactor wall.

The plate may be made in sections 7 as shown in Fig 6b.

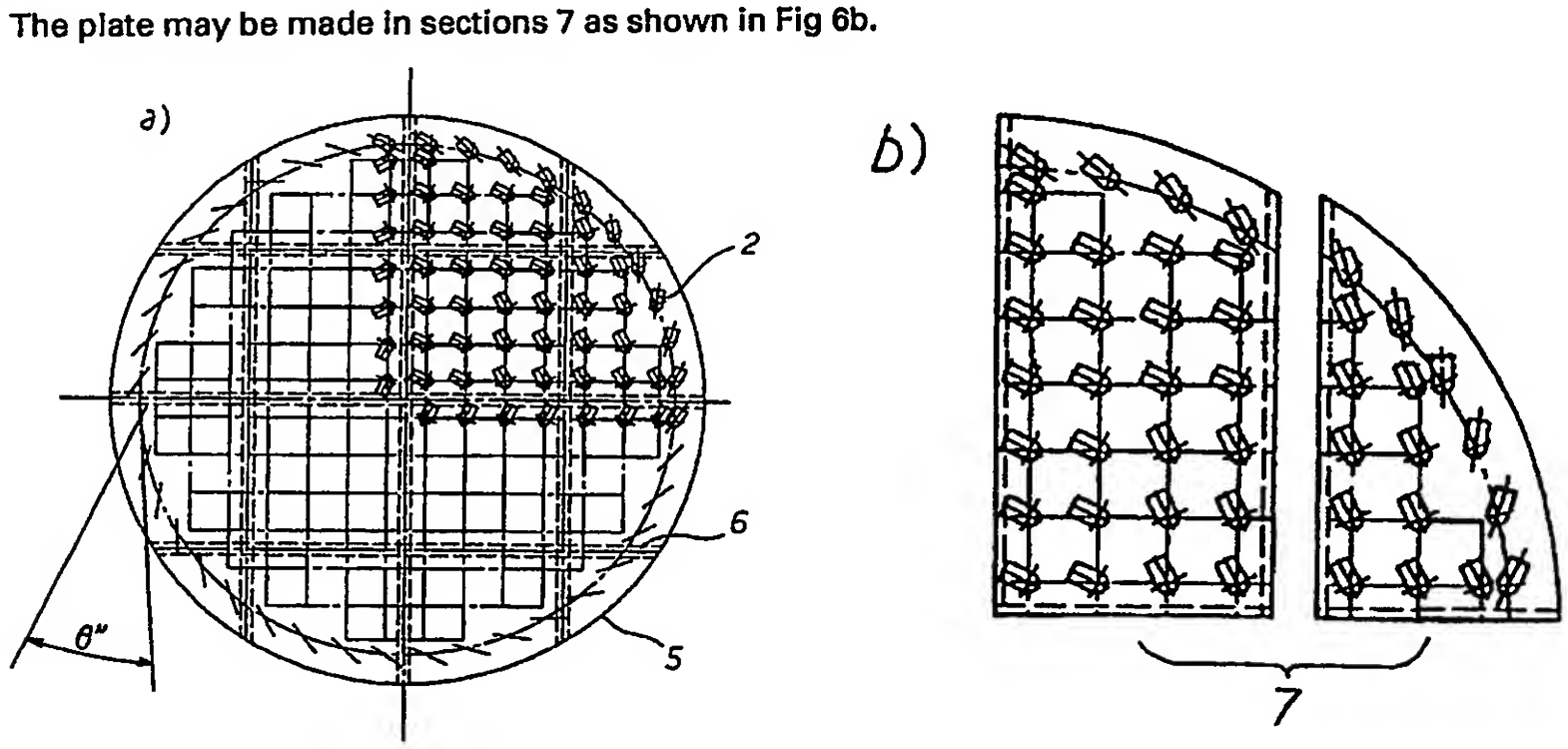

FIG. 6

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FIG. 1

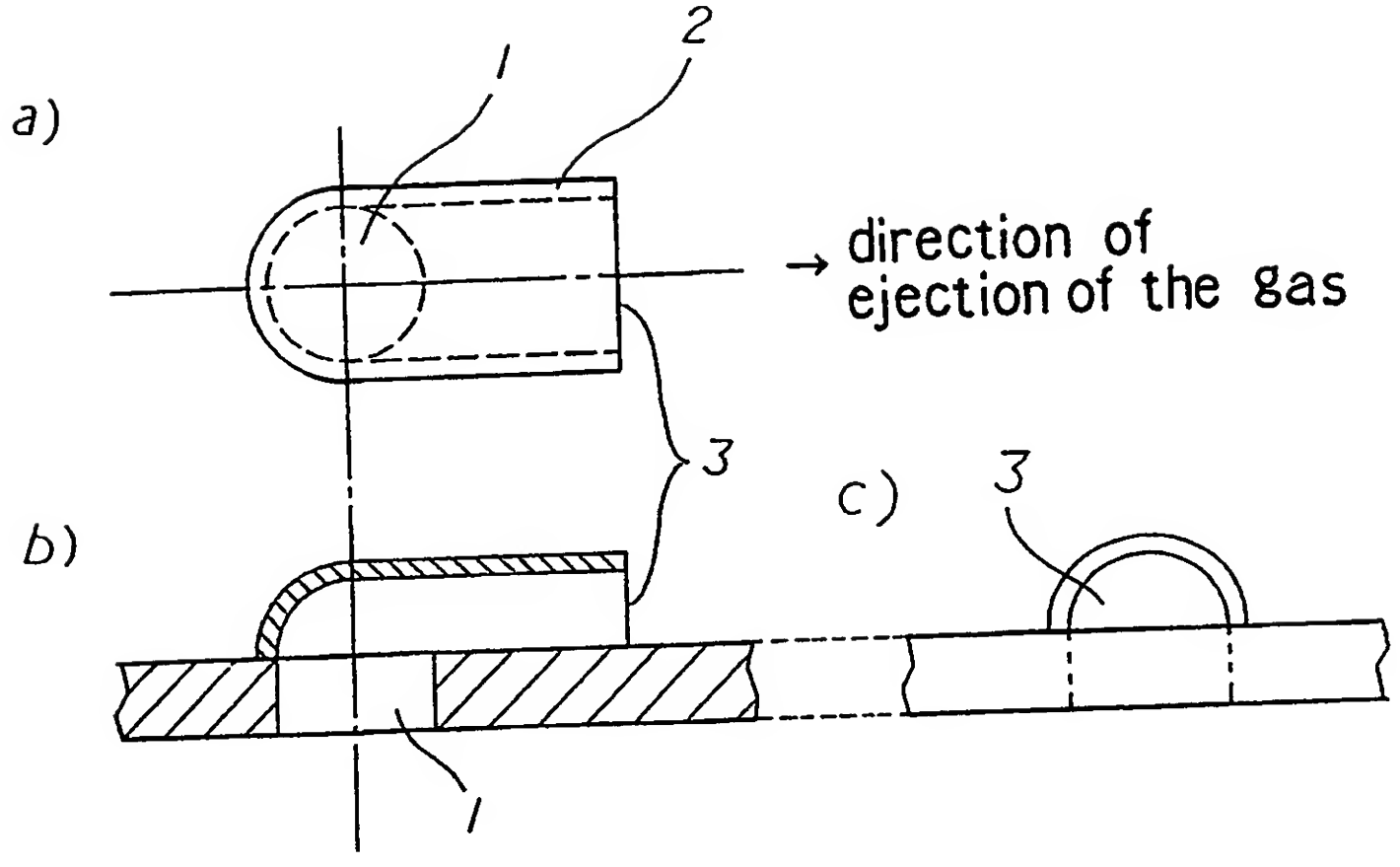


FIG. 2

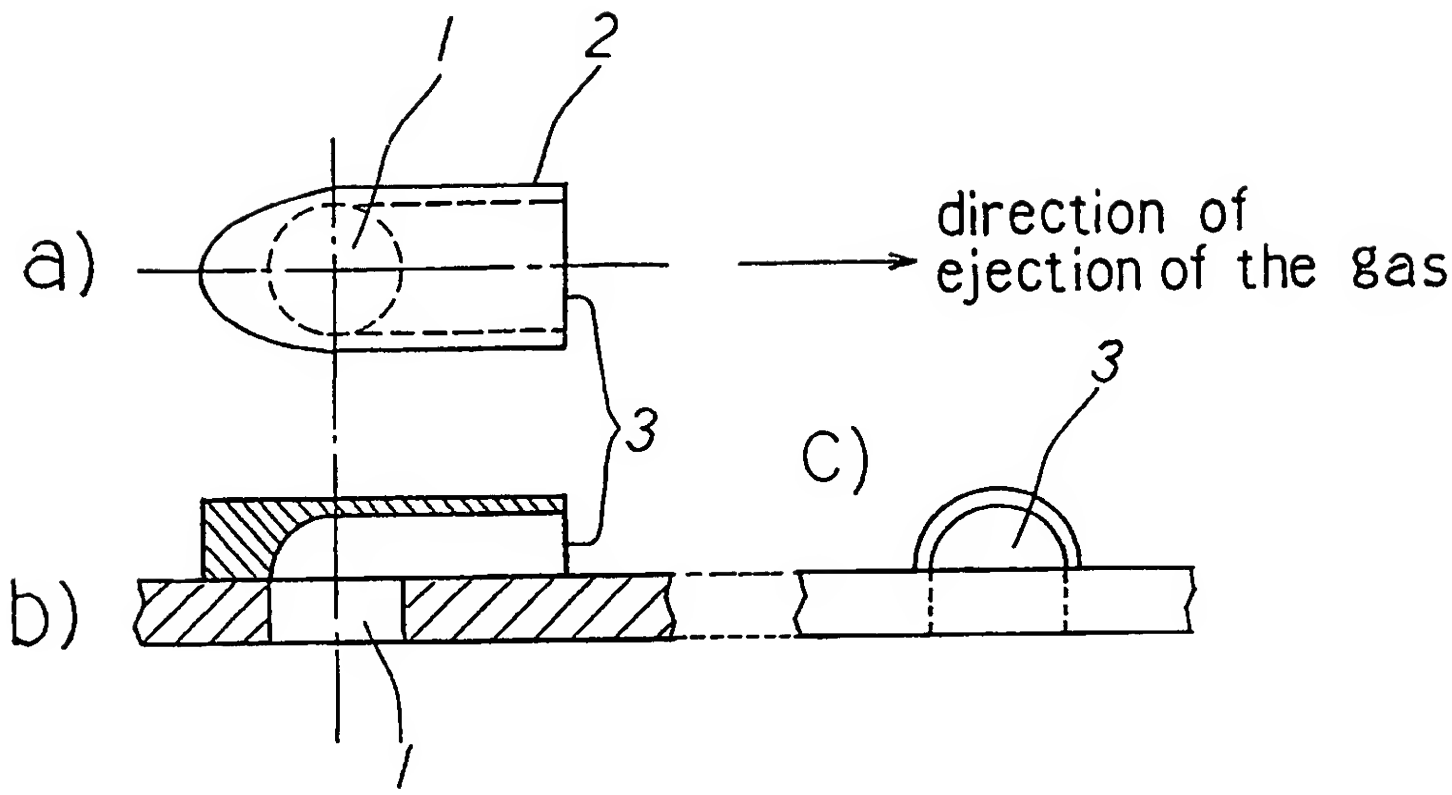

1
2
a)
direction of
ejection of the gas
3
C)
3
b)
1

FIG. 3

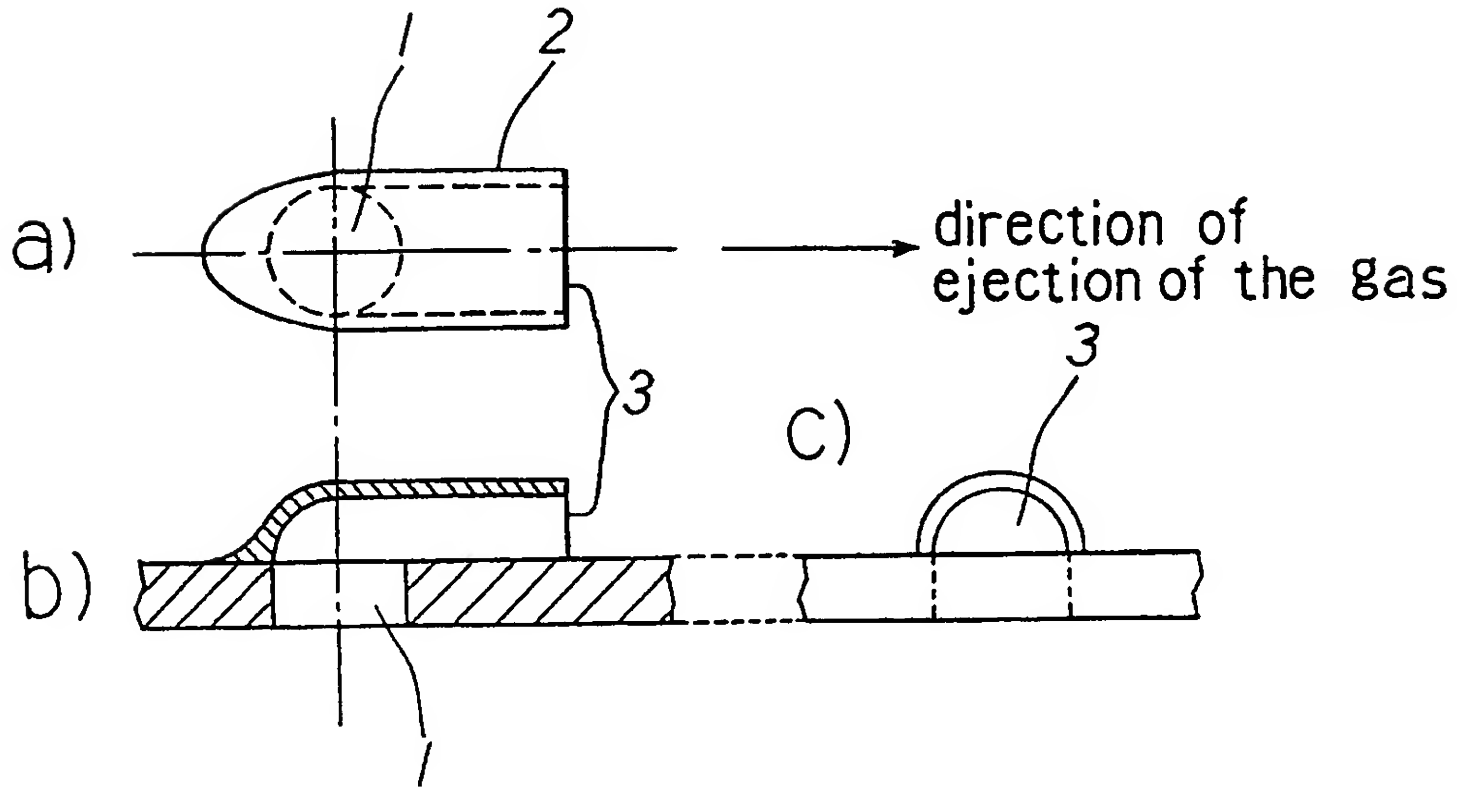

1
2
a)
direction of
ejection of the gas
3
3
C)
b)
1

FIG. 4

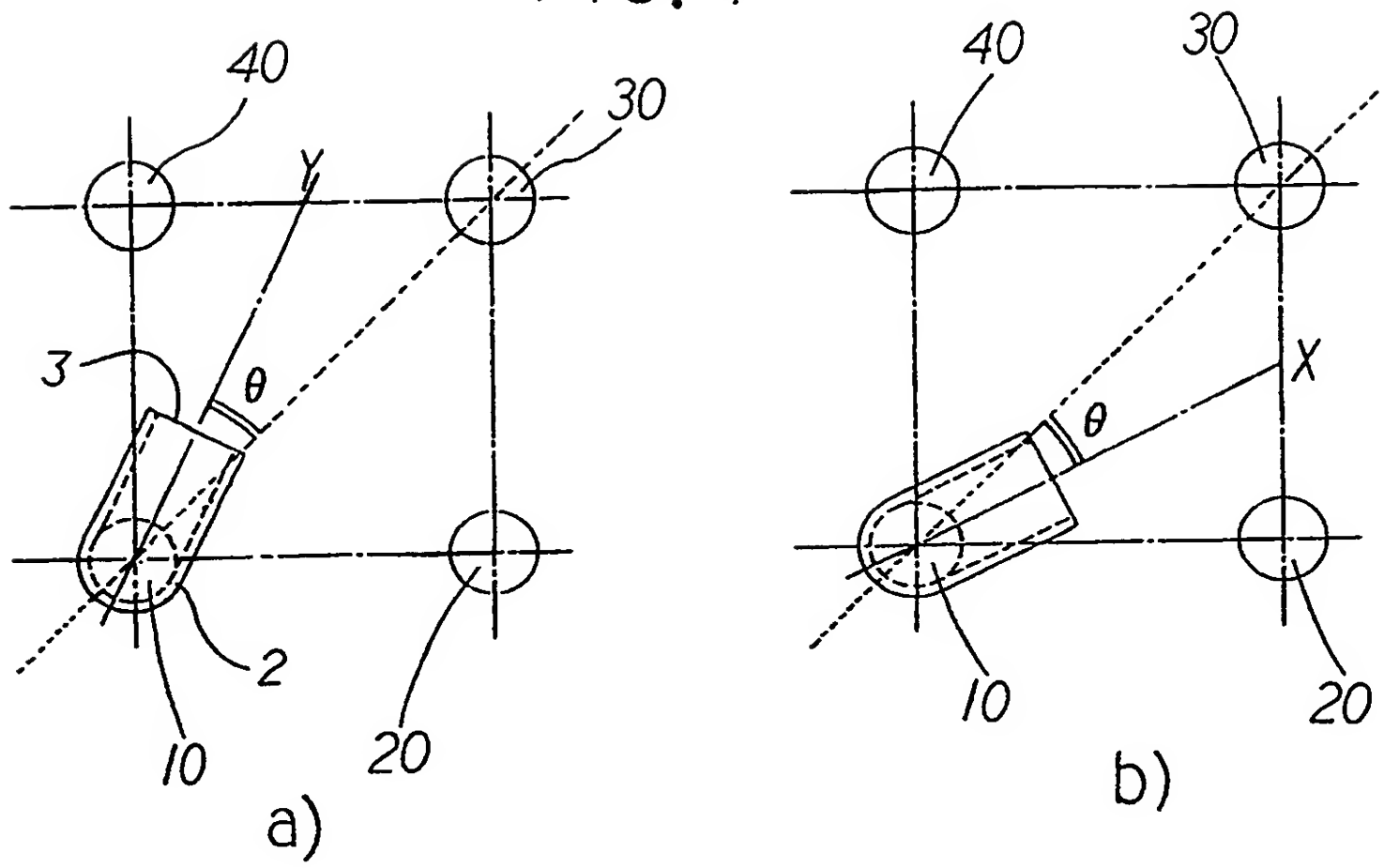

40
30
Y
3
θ
2
10
20
a)
40
30
X
θ
10
20
b)

FIG. 5

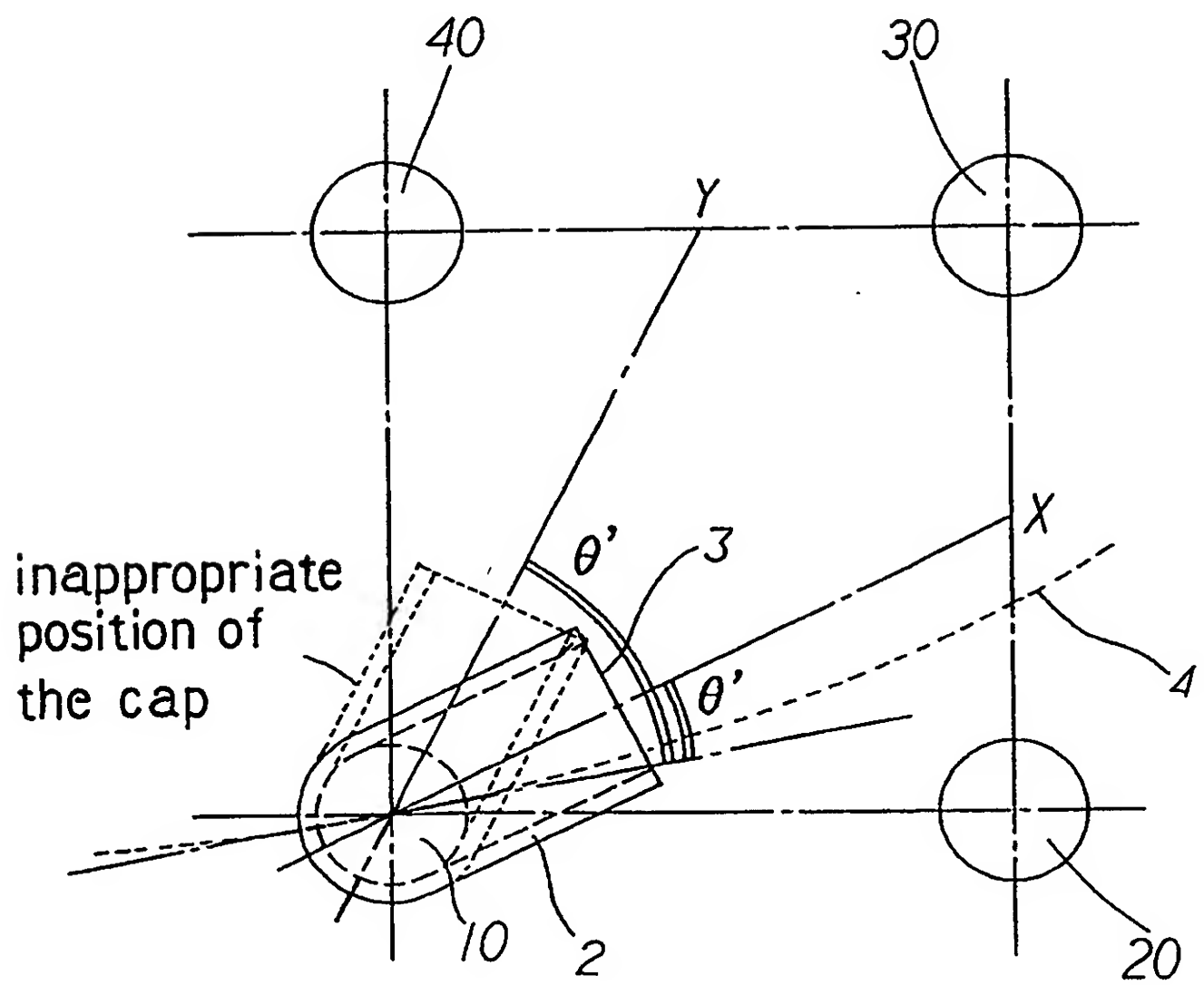
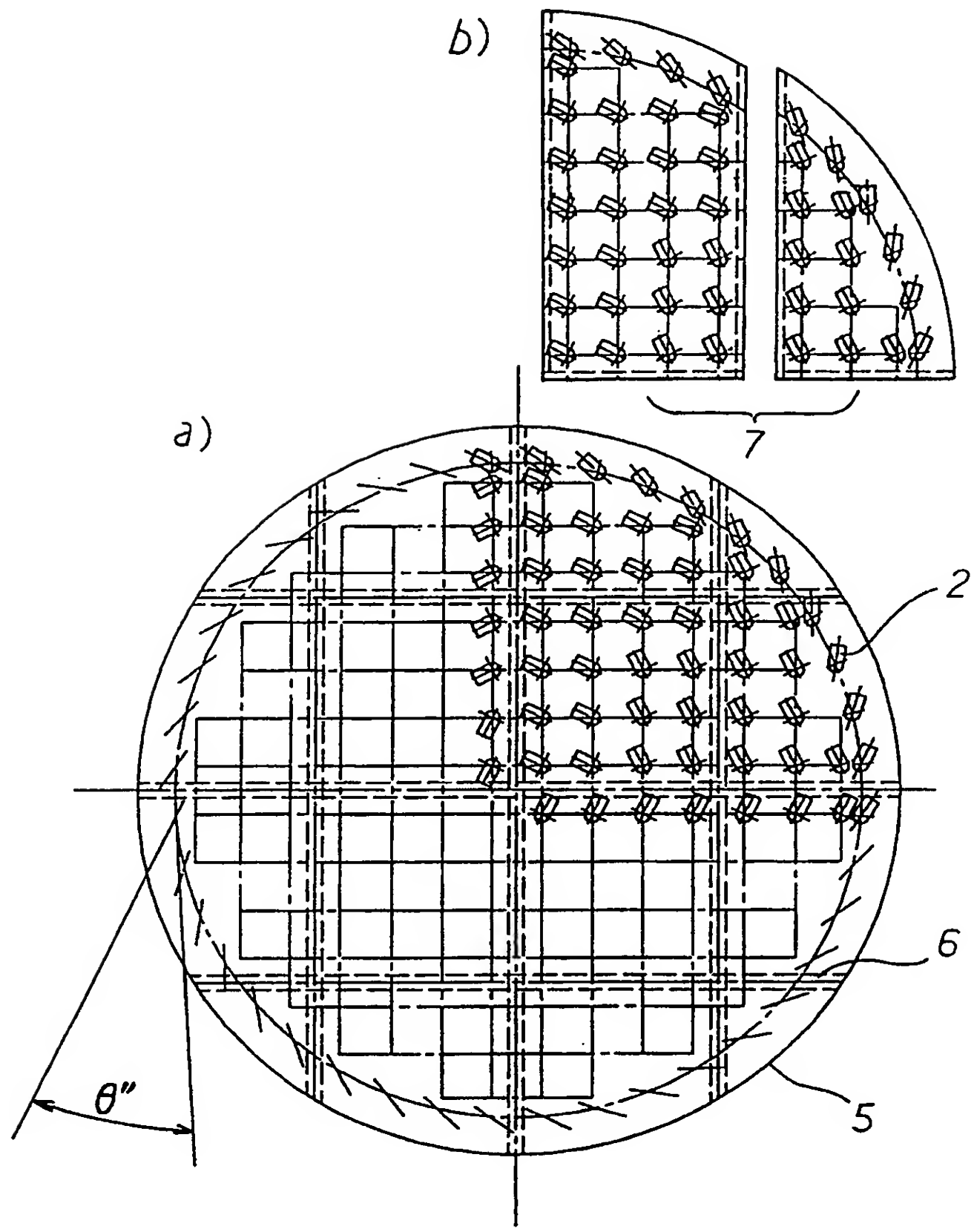

40
30
Y
X
θ'
3
θ'
4
inappropriate
position of
the cap
10
2
20

FIG. 6



GAS DISTRIBUTOR PLATE FOR FLUIDIZED BED REACTORS

The present invention relates to gas distributor plates for fluidized bed reactors suited to gas phase polymerization of olefins such as ethylene and propylene. The gas distributor plates of the present invention are usable also in fluidized bed reactors equipped with a stirrer.

The terms "polymerization" and "polymer" as used herein include "homopolymerization" and "copolymerization", and "homopolymer" and "copolymer", respectively.

In recent years, improvements in catalysts of transition metal for use in the polymerization of olefins have remarkably improved the productivity of olefin polymers per unit amount of the transition metal, consequently obviating the need for the removal of the catalyst after the polymerization.

When such highly active catalysts are used, olefins are generally polymerized in a gas phase since the polymerization reaction mixture can then be handled by the simplest procedure. Usually, fluidized bed reactors are widely used in the gas phase polymerization so as to effect the reaction smoothly. The olefin or an olefin-containing gas introduced into a lower portion of

the reactor through a supply pipe is forced upward and is uniformly distributed by a gas distributor plate to cause an olefin polymer and the catalyst in the form of polymer particles to mix within a fluidized bed for polymerization.

Perforated plates may be used as gas distributor plates in fluidized bed reactors of the type mentioned. However, the holes are likely to become clogged up by deposition of polymer particles so as to make it impossible for the polymerization apparatus to continuously operate for a long period of time. If the holes are given a large size, the problem of clogging will be overcome to some extent, but polymer particles then fall through the holes to become deposited on a wall below the gas distributor plate, or an increase in the distance between the holes, i.e., in the hole pitch, is likely to create a region of stagnant flow between the holes. The heat of polymerization is not removable sufficiently in this case, giving rise to troubles such as agglomeration of the polymer and entailing the great likelihood of the cessation of operation.

To solve these problems, gas distributor plates are proposed which are provided with a cap over the hole. For example, a roof-shaped cap is proposed in Unexamined

Japanese Patent Publication SHO 57-079543, a triangular pyramidal cap in the same publication SHO 58-154702, a cap having a partition wall in the same publication SHO 58-196205, a bubble cap in the same publication SHO 58-201802 and an angle cap in the same publication SHO 61-106608.

On the other hand, an stagnant flow is liable to occur immediately above the gas distributor plate in the regions between the holes regardless of the size of the holes. Troubles such as agglomeration of the polymer occur also in this case, leading to the great likelihood of the cessation of operation and degradation of the product.

To overcome this problem, a method is devised of producing a whirling gas flow on the gas distributor plate by giving directivity to the gas to be forced out through the distributor plate (Iwao Muchi, "Reaction Engineering of Fluidized Beds," p. 85, published in 1983 October by Baifukan).

Another proposal is made of producing a whirling flow using a distributor plate which has caps arranged on concentric circles for ejecting a gas horizontally in one direction as disclosed in Unexamined Japanese Patent Publication HEI 01-284509. According to Unexamined Japanese Patent Publication HEI 03-157405,

such a flow is produced with use of a gas distributor which comprises a plate having holes in a staggered arrangement for ejecting a gas horizontally in one direction, or which comprises an assembly of such plates in combination.

However, these gas distributor plates are unable to fully preclude troubles such as deposition or agglomeration of polymer particles, failing to hold the charges in a satisfactorily fluidized state.

Further generally with large reactors for commercial operation, the gas distributor plate needs to withstand polymer particles weighing tens of tons and requires a support structure under the plate. The gas distributor plate nevertheless has holes in an irregular or concentric circular arrangement, so that when a support structure of reinforcing beams is to be provided beneath the plate, some of the holes become closed with the structure if it has a simple construction, for example, like a lattice.

Accordingly, such distributor plates inevitably have the problem of necessitating a support structure having a complex construction, e.g., a concentric circular arrangements of components.

According to the present invention there is provided a gas distributor plate for use in a fluidized bed reactor wherein the plate has holes that are arranged respectively at the vertices of a multiplicity of phantom squares adjoining to one another on the distributor plate, each of the holes being covered with a respective cap having an outlet for orienting a gas to be ejected from the outlet in a predetermined direction, the direction of ejection of the gas from an outlet positioned at a vertex of a square in use being substantially parallel to the surface of the plate and along a line which, when the plate is mounted in the reactor, is in a generally circumferential direction with regard to a circle through the vertex and centred about the centre of the reactor so as to form a whirling flow of the gas upon ejection.

Thus, having conducted extensive research on gas distributor plates for maintaining a satisfactory fluidized bed free of troubles such as deposition or agglomeration of polymer particles, a gas distributor plate was invented which has holes in a specified arrangement and each provided with a cap thereover as oriented in a specified direction to overcome the foregoing problems. This finding and further studies have matured the present invention.

The invention will be more clearly understood from the following description, given by way of example only with reference to the accompanying drawings in which:

FIG. 1 is a drawing showing an embodiment of cap for use in the present invention, a) being a plan view of the cap provided over a hole, b) being a side elevation of the same, c) being an elevation of the same;

FIG. 2 is a drawing showing another embodiment of cap for use in the present invention, a) being a plan view of the cap provided over a hole, b) being a side elevation of the same, c) being an elevation of the same;

FIG. 3 is a drawing showing another embodiment of cap for use in the present invention, a) being a plan view of the cap provided over a hole, b) being a side elevation of the same, c) being an elevation of the same;

FIG. 4 includes plan views of caps oriented in two different directions at a preferred angle and provided for one of holes in an arrangement of the phantom square;

FIG. 5 is a plan view of a cap provided over a hole and positioned at a selected smaller angle θ which a tangent to a circle through the hole makes with the

direction of ejection of gas from the cap; and

FIG.6 show embodiments of the invention, a) being a plan view of a gas distributor plate to show some of the caps thereon, b) being a plan view showing some component segments of a gas distributor plate.

An embodiment of the present invention provides a gas distributor plate which has a multiplicity of holes in a square arrangement except at a portion thereof to be positioned close to the side wall of a reactor. For example, the phantom squares for the arrangement of holes are constituted by crossed lines equidistantly running. "The distance between the holes, i.e., the hole pitch, is determined in accordance with the opening ratio of the distributor plate, that is, the ratio of the total opening area of outlets of caps over the holes in the distributor plate to the total cross sectional area of the reactor, and with the diameter of the outlets of the caps. Preferably, the opening ratio is so determined that the required pressure loss of the distributor plate will be about 40% of the total pressure loss in order to form a bed which is uniformly fluidized radially thereof. The outlet diameter is preferably at least 5 times the average diameter of polymer particles since the outlets of the distributor plate are likely to be clogged if it is less than 5 times the average diameter of polymer

particles. On the other hand, it is desirable that the hole pitch be as small as possible because an excessive pitch permits formation of a region of stagnant flow between the holes. Accordingly, the opening ratio is usually 0.5 to 10%, preferably 0.5 to 5%, more preferably 1 to 3%. The diameter of the outlets of the caps is usually 5 to 30 mm, preferably 5 to 20 mm, more preferably 10 to 20 mm. The hole pitch is usually 15 to 400 mm, preferably 30 to 200 mm, more preferably 30 to 100 mm.

The present invention will be described below in greater detail with reference to the accompanied drawings.

FIGS. 1 to 3 are drawings showing different embodiments of caps for use in the present invention. In each of these drawings, a) is a plan view of the cap, b) is a side elevation of the same, and c) is an elevation of the same.

With reference to FIG. 1, a cap 2 provided over a hole 1 has a streamlined contour as shown in FIG. 1, a) or b) so as not to impede a whirling flow of gas and not to create a stagnant flow upstream from the cap. The cap has an outlet 3 having a contour which is, for example, semicircular as shown in FIG. 1, c) to cause the gas to flow out horizontally in one direction.

The outlet may alternatively has a flat triangular or rectangular contour. FIGS. 2 and 3 show caps which are streamlined and resemble the front half of a boat as turned upside down. The caps having streamlined contours are not limited to those shown in FIGS. 1 to 3. When the hole is provided with a cap so constructed as described above, the distributor plate is usable free of the problem that polymer particles fall through the plate unlike the conventional perforated plate. Such caps are arranged as oriented in a specified direction, for example, circumferentially of the distributor plate, whereby a circumferential flow of gas, namely a whirling gas flow, is produced on the plate during fluidization. This whirling flow effects satisfactory fluidization and mixing throughout the entire fluidized bed, especially in the bottom portion of the bed. Even if some agglomerates are produced, the agglomerates are quickly moved or whirled centrifugally to the outer peripheral portion of the distributor plate, and are discharged before they grow into large masses.

Such caps are arranged respectively over the above-mentioned holes on the distributor plate. The direction of the gas to be ejected from the outlet of the cap positioned at each vertex of each square is substantially horizontal and is from the vertex of the

square toward a position on a side between two other vertices of the same square which are close to a circle through the vertex and centered about the center of the reactor so as to form a whirling flow of the gas upon ejection.

The cap is provided as oriented in one of two directions as shown in FIG. 4. More specifically, FIG. 4 includes plane views a) and b) showing caps arranged in two different directions at a preferred angle and each provided over a hole at the vertex of the phantom square. With reference to FIG. 4, the outlet 3 of the cap 2 provided over a hole 10, that is, the gas ejected from the hole 10, is oriented toward an approximate midpoint X between a hole 30 and a hole 20 or toward an approximate midpoint Y between the hole 30 and a hole 40. The angle θ at which the cap is positioned with respect to a diagonal through the holes 10 and 30 is 10 to 30°, preferably 15 to 25°. When the angle θ is 10 to 30°, the gas flowing out from the hole 10 passes over the point X or Y between the holes 30 and 20 or between the holes 30 and 40 which are positioned downstream from the hole 10.

However, for the gas distributor plate of the present invention to produce a whirling flow, the direction in which the gas is to be ejected from the cap is determined according to the angle θ' as shown in FIG.

5. An angle θ′ is formed between a tangent to a circle 4 concentric with the outer periphery of the reactor and extending through the hole 10 at the vertex of the square and the direction of the outlet 3 of the cap 2, i.e., the direction of the gas to be ejected. The direction of the ejection can be so determined that the angle θ′ is smaller. FIG. 5 is a plan view of a cap which is so positioned that the angle θ′ a tangent to the circle through the hole 10 makes with the direction of ejection of the gas from the cap is smaller as shown in FIG. 4, b).

The gas flowing out from the outlets of the caps over the holes is forced out substantially in the turning direction of the fluidized bed, e.g., rightward or leftward turning direction, consequently producing an overall whirling flow.

The caps can be attached to the distributor plate by any method insofar as the whirling flow produced on the plate will not be thereby impeded. The caps can be attached, for example, by welding or with screws, preferably by welding.

The gas distributor plate of the invention further has additional holes along a circle in an outer peripheral portion of the plate close to the side wall of the reactor. Each of the holes is provided with a cap,

like those described above, for forcing out the gas from the outlet of the cap outwardly of the direction of a tangent to the circle. Consequently, the gas removes the particles adhering to the side wall, promoting fluidization and mixing in the vicinity of the side wall in the bottom portion of the bed. The diameter of the outlets, the spacing between the holes and the distance of the holes from the side wall are not limited specifically insofar as the above effect is available. For example, the outlet diameter, and the hole spacing and the distance of the holes from the side wall are nearly the same as the diameter of the outlet and hole pitch in the square arrangement described. For example, the outlet diameter is usually 5 to 30 mm, preferebly 5 to 20 mm, more preferebly 10 to 20 mm. The hole spacing and the distance of the holes from the side wall are usually 15 to 400 mm, preferably 30 to 200 mm, more preferably 30 to 100 mm.

Preferably, the cap is oriented substantially in the same direction as the revolution of the whirling flow of the gas ejected from the outlets of the caps in the square arrangement so that the gas forced out from the cap flows along the whirling flow, the cap having an angle θ'' (FIG. 6, a)) of 20 to 70° with respect to the direction of a tangent to the above-mentioned circle

the gas from each cap to be determined is within the above angular range so as to produce a whirling gas flow on the distributor plate. For installation, the segments are arranged in contact with one another without a clearance therebetween, and the contact portions are joined together, for example, by welding or with screws, and a support structure 6 is disposed beneath the gas distributor plate, which is then secured to the structure by welding or with screws or the like. The gas distributor plate of the present invention has holes in a square arrangement except at its outer peripheral portion, so that a support structure of simpler construction than in the prior art, such as the latticelike one shown in FIG. 6, a), is usable without blocking some of the holes merely when the pitch of holes in the outer peripheral plate portion is suitably adjusted.

As described in detail above, use of the gas distributor plate of the above embodiment of the present invention improves the fluidized and mixed state of the fluidized bed in the vicinity of the reactor side wall or on the distributor plate where polymer particles are liable to adhere or form agglomerates or lumps due to stagnation to ensure a stabilized continued operation for a long period.

Furthermore, the gas distributor plate of the present

invention is easier to make and reinforce by a support structure than those of the prior art.

Example 1

Using an experimental fluidized bed device measuring 1000 mm in inside diameter, a fluidized bed was formed and checked for the presence or absence of an improperly fluidized portion immediately above a gas distributor plate. The gas distributor plate used in the experimental device was of the same type as shown in FIG. 6, a). The distributor plate had holes in square arrangement which were 16 mm in diameter and 66 mm in hole pitch, and outermost holes arranged along the outer periphery of the distributor plate and close to the side wall of the device and having a diameter of 16 mm and hole pitch of 66 mm. Each of the holes was provided thereover with a cap having an outlet of 16 mm in diameter. The caps were of the same type as shown in FIG. 1 and had a semicircular outlet. Each of the caps over outermost holes was oriented substantially in the same direction as the revolution of whirling flow of the gas to be ejected from the outlets of the caps over the holes in the square arrangement so that the gas forced out from the cap flowed along the whirling flow, and which had an angle θ" (see FIG. 6, a)) of 30° outwardly with respect to the tangential direction previously

mentioned. Colored polyethylene particles (920 μm in mean particle size) were placed over the distributor plate to such a level that the caps were fully covered therewith, and uncolored like polyethylene particles were further placed over the layer of colored particles to a height of 1.5 m thereabove.

In this state, nitrogen gas was supplied to the device under atmospheric pressure at a flow rate of 1400 m^3/hr to fluidize the resulting layer of particles for 5 min. The particulate polymer was thereafter withdrawn from above in small portions to observe the position of colored polymer particles remaining on the gas distributor plate. Consequently, little or no colored polyethylene was found over the entire area of the distributor plate inclusive of the portions between the outlets and close to the side wall of the device.

Comparative Example 1

The procedure of Example 1 was repeated with the caps over the outermost holes of the gas distributor plate closed with plugs. Consequently, colored polyethylene particles were found undiffused and remaining locally in the vicinity of the side wall.

CLAIMS

1. A gas distributor plate for use in a fluidized bed reactor wherein the plate has holes that are arranged respectively at the vertices of a multiplicity of phantom squares adjoining to one another on the distributor plate, each of the holes being covered with a respective cap having an outlet for orienting a gas to be ejected from the outlet in a predetermined direction, the direction of ejection of the gas from an outlet positioned at a vertex of a square in use being substantially parallel to the surface of the plate and along a line which, when the plate is mounted in the reactor, is in a generally circumferential direction with regard to a circle through the vertex and centred about the centre of the reactor so as to form a whirling flow of the gas upon ejection.

2. A gas distributor plate as defined in claim 1 further comprising holes to be positioned adjacent to a side wall of the reactor, the direction of ejection of the gas from an outlet of a hole positioned adjacent to the reactor side wall in use being outward from the direction of a tangent to a circle through the hole and centred about the centre of the reactor and substantially along the whirling flow.

3. A gas distributor plate as defined in claim 2 wherein the phantom squares for the arrangement of holes are constituted by crossed lines quidistantly running and are

insid of the holes at positions adjacent to a side wall of the reactor.

4. A gas distributor plate as defined in claim 2 or 3 wherein the outlets of the caps over the holes that are, in use, adjacent to the side wall of the reactor are positioned in a circle in an outer peripheral portion of the plate.

5. A gas distributor plate as defined in claim 2, 3 or 4 wherein the outlets of the caps over the holes in use positioned adjacent to the reactor side wall have a diameter of 5 to 30 mm, and the holes in use positioned adjacent to the reactor side wall are arranged at a spacing of 15 to 400 mm and in use spaced apart from the side wall by 15 to 400 mm.

6. A gas distributor plate as defined in any one of claims 2 to 5 wherein the caps provided over the holes positioned in use adjacent to the reactor side wall have their outlets oriented outwardly of the direction of a tangent to a circle concentric with a cross section of the reactor at an angle of 20 to 70° with the tangential direction.

7. A gas distributor plate as defined in any preceding claim wherein said line lies from the vertex of the square toward a position on a side between two other vertices of the same square which are adjacent.

8. A gas distributor plate as defined in any preceding claim 1, wherein said caps comprise caps having an outlet with a semicircular contour.

9. A gas distributor plat as d fined in any

preceding claim wherein said caps comprise caps having an outlet with a semicircular contour.

10. A gas distributor plate as defined in any preceding claim wherein said caps comprise caps having an outlet with a rectangular contour.

11. A gas distributor plate as defined in any preceding claim wherein the outlets arranged at the vertices of the phantom squares have a diameter of 5 to 30 mm, and the holes are arranged at a pitch of 15 to 400 mm.

12. A gas distributor plate as defined in any preceding claim which comprises at least two segments to be assembled into a main body and to be arranged horizontally in combination.

13. A gas distributor plate as defined in any one of claims 1 to 11 for use in combination with at least one other gas distributor plate as defined in any one of claims 1 to 11.

14. A gas distributor plate as defined in any preceding claim which is used for a fluidized bed reactor provided with a stirrer to be positioned within the said reactor.

15. A gas distributor plate as defined in any preceding claim which is provided with a reinforcing support structure beneath the plate.

16. A gas distributor plate for use in a fluidized bed reactor wherein the plate has a plurality of holes including at least two parallel rows of hol s having none of

said plurality f holes thereb tw n, each f said holes being covered with a respective cap having an outlet for orienting a gas to be ejected from the outlet in a predetermined direction, the direction of ejection of the gas from an outlet positioned at a vertex of a square in use being substantially parallel to the surface of the plate and along a line which, when the plate is mounted in the reactor, is in a generally circumferential direction with regard to a circle through the vertex and centred about the centre of the reactor so as to form a whirling flow of the gas upon ejection.

17. A gas distributor plate according to claim 16 comprising a plurality of said parallel rows such that at least some of the holes in said rows are arranged respectively at the vertices of at least one phantom square.

18. A gas distributor plate constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.

19. A fluidized bed reactor incorporating a gas distributor plate as defined in any preceding claim.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9321985.5
Relevant Technical Fields (i) UK Cl (Ed.L) B1F (ii) Int Cl (Ed.5) B01J 8/44, F23C 11/02, F27B 15/10	Search Examiner J H WARREN Date of completion of Search 12 JANUARY 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI AND CLAIMS	Documents considered relevant following a search in respect of Claims :- 1-19

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	EP 0482799 A1 (FOSTER WHEELER) nozzles 36	
A	US 4933149 A (UNION CARBIDE) arrangement of nozzles in Figure 4	

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

The San Jacinto College District

Class Schedule Search

CR Fall 2003 for North Campus

ACCT 2301 Accounting Principles I

(Formerly Accounting 2311) A study of the fundamentals of financial accounting. Includes a procedures, concepts and theory for proprietorships, partnerships, and corporations. Emphasi cycle for service and merchandising enterprises. Prerequisite: Reading (3:3-1.5)

Day

CRN	Course NO.	Day	Time	Instructor	Location	Beg Date	Wks
12921	ACCT 2301.201	MW	0900 - 1115	Strout, Dan	A2003 NADM	08/25/2003	16
12921	ACCT 2301.201	MW	0900 - 1115	Strout, Dan	A2003 NADM	08/25/2003	16
12923	ACCT 2301.202	TR	1000 - 1215	Black, Margaret	B1005 NADM	08/25/2003	16
12923	ACCT 2301.202	TR	1000 - 1215	Black, Margaret	A1012 NTEC	08/25/2003	16

Evening

CRN	Course NO.	Day	Time	Instructor	Location	Beg Date	Wks
12970	ACCT 2301.203	M	0700 - 1000	Black, Margaret	A1012 NTEC	08/25/2003	16
12970	ACCT 2301.203		-	Black, Margaret	A1012 NTEC	08/25/2003	16
14723	ACCT 2301.204	R	0700 - 1000	Georgas, Nick	A2010 NTEC	08/25/2003	16
14723	ACCT 2301.204		-	Georgas, Nick		08/25/2003	16

Distance Learning

CRN	Course NO.	Day	Time	Instructor	Location	Beg Date	Wks	St
12691	ACCT 2301.271		-	Whitmore, Randall		08/25/2003	16	9

Back